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Abstract. Changqu, located in Xiangyang City, northwest of Hebei Province and in the middle reaches of Manhe River Basin of Hanjiang River, tributary of the Yangtze River, is a "Joining reservoirs" type water storage and diversion irrigation project with a long history of more than 1200 years. Based on the origin, evolution and management research of Changqu, this paper puts forward the composition of Changqu water conservancy heritage and analyzes its value.

1. Introduction

Changqu, located in Xiangyang City, northwest of Hebei Province and in the middle reaches of Manhe River Basin of Hanjiang River, tributary of the Yangtze River, is a "Joining reservoirs" type water storage and diversion irrigation project with a long history of more than 1200 years. The construction of Changqu has greatly promoted the agricultural development and economic construction of Xiangyang Plain, making this region become a famous granary in the middle reaches of Hanjiang River. The maximum irrigated area in history was more than "6,000 hectares" and the current irrigated area is 202km^2, dominated by rice agriculture. Changqu is a model of the sustainable irrigation project.

2. Historical Development

Xiangyang is located in the northwest of the plain in the middle reaches of Hanjiang River and is a transitional zone between hills and plains. The average annual precipitation in the Xiangyang Plain for many years is 900mm, but the annual distribution is uneven. Since the Qin and Han Dynasties, Xiangyang has been an important agricultural economic zone and has also become the demarcation line of the civil war for several times.

At the end of the Warring States Period, the powerful Qin State began to conquer the Chu State. According to the historical records, the general of the Qin State built dams and canals for flooding the enemies in the 276 BC[1]. This project built for wars soon became an important irrigation project in the Xiangyang Plain and named "Baiqiqu" for commemorating its founder. Because the main canal of Changqu is about 100 miles long, it has been mostly called "Changqu" in the history books since the Tang Dynasty[2].

In the 3rd Century, Muqu was built in the north of Changqu. Muqu diverts water from Yanshui, another branch of the Hanjiang River. The canal systems of Changqu and Muqu were interlinked in the Han Dynasty, forming a large irrigation area of "more than 6,000 hectares" between Xiangyang and Yicheng at present. Xiangyi Plain has become the granary of the middle reaches of the Hanjiang River.

Changqu and Muqu, which had been improved over the past 600 years from the Qin and Han Dynasties to the Northern and Southern Dynasties, became a regional irrigation project with the functions of water diversion and storage in the 5th Century. Changqu and Muqu ingeniously use the terrain, "connecting the impouding reservoirs with fields by canals", and is a joining reservoirs type irrigation project with water diversion and storage.

In history, Changqu and Muqu fell into disrepair and were abandoned for many times due to wars and rebuilt after the return of peace. In the 11th Century, Sun Yong, Magistrate of Yicheng County, carried out the reestablishment, which was the important restoration to Changqu. He not only rebuilt the project, but also set up a self governance system in the irrigation area, which was supervised by the government.

In the 12th Century, the Xiangyang area in the middle reaches of the Hanjiang River became the key point of confrontation between the Southern Song Dynasty and Mongolia. The central government of the Southern Song Dynasty attached great importance to the treatment and management of the irrigation projects in Xiangyi Irrigation Area for the needs of the military field and the emperor had issued the imperial edict for many times personally for finishing as well as the government and the army jointly managed the irrigation project in this area. In this period, the project system was more perfect and the canal was connected with the impouding reservoirs, densely covered by rivers and canals. Xiangyi Plain became the special economic zone of "fertile soil and no disasters within hundred miles" [3].

From the 13th Century to the early 20th Century, Changqu and Muqu have adopted the management system combined with official and civilian self-governance. During the Ming and Qing Dynasties, due to the economic center transformation, uneven irrigation benefits between the upper and lower reaches of Changqu and contradiction between water transport and irrigation of the canal, the canal engineering system was mostly neglected and partially restored until modern times.

In the past, four major repairs were carried out on the canals of the Changqu irrigation area. After every major repair, it can be maintained for 200-400 years of irrigation if there is no serious damage during the war. Over the past 2000 years, the time of water diversion and disuse has accounted for half of the total.

In the 19th Century, due to the sharp contradiction between upstream water transportation and downstream irrigation, the diversion project in the irrigation area was once out of repair and in the middle of the 20th Century, Changqu was rebuilt at its original site.

The construction of Changqu Project has played a significant economic benefit in irrigation, flood control and drainage, ecological agriculture and other aspects. Over the past 2000 years, it has greatly promoted the agricultural development and economic construction of Xiangyi Plain, making this region become a famous granary in the middle reaches of the Hanjiang River. At present, the main benefits of Changqu are irrigation and flood control.

Changqu has undergone many engineering repairs in many dynasties to continuously improve its management methods, so that it has not been annihilated after more than 2000 years of natural landform evolution. In particular, since the Han and Tang Dynasties, Changqu continued to bring the benefits, greatly promoting the social stability and economic development of the Hanjiang River region and bringing the harvest of grain production, the flourishing of planting mulberry trees and breeding silkworms, planting cotton and doubling thread and development of the fishery and animal husbandry.

Li Daoyuan in the Northern Wei Dynasty wrote *Commentary on the Waterways Classic*, indicating that Changqu (Baiqiqu) can irrigate 3,000 hectares and Muligou (Muqu) can irrigate 700 hectares. According to *Mathematical Classic of Five Kinds of Officials*, the mu law was calculated in 240 steps

at that year, a mu equal to 0.8 mu. According to this calculation, 3,000 hectares irrigated by Changqu is equal to 240,000 mu and 700 hectares of Muqu is equal to 56,000 mu. Zheng Xie in the Song Dynasty wrote *Muqu in Yicheng County of Xiangzhou*, which said that Wang Chong, Prefecture Chief of Hannan Prefecture, excavated the Manshui again to connect to it, thus irrigating 6,000 hectares. In the Han Dynasty, a mu was equal to 0.7 mu, that is, 6,000 hectares were equal to 420,000 mu, which was the total irrigated area of an irrigation system formed by Changqu and Muqu (Changqu's control area is about 50,000 mu and actual irrigated area is 270,000 mu at present.) *Muqu in Yicheng County of Xiangzhou* also mentioned that, "by the Cao Wei period, Mei Fu brothers gathered more than ten thousand households here to live. Therefore, it was called fertile land at that time. Zhu Ran, General of the Wu State, tried to conquer this place with two troops but failed." In the 33rd year of Shaoxing of the Southern Song Dynasty (1162), After Wang Che presided over the restoration of Changqu and Muqu, 38 villages were set up in the irrigation area for reclamation, with the annual harvest of 7,500,000 dou, equal to 42,420,000 jin, that is, 21,210,000 kg. In the 6th year of Dade of the Yuan Dynasty (1302), after Li Ying presided over the restoration, the benefits of these two canals have lasted for more than 100 years, until the 15th Century, and then were gradually annihilated.

After the restoration by the People's Republic of China, more than 14 billion cubic meters of agricultural and industrial water have been supplied to Nanzhang County and Yicheng County and the total annual grain output of the irrigation area reached 250 million kilograms, fully playing the role of the bringing the benefit and abolishing the harm of the water conservancy project, playing an important role in resisting the drought and flood disasters, ensuring the safety of the grain production and realizing the increase of agricultural production and increase of farmers' income and bringing great economic, social and ecological environmental benefits. Yicheng City, the main irrigation area, is called agricultural "Little Fatty" county and is one of the first batch of ton-grain fields in the country and 484 high-quality grain project counties (cities); as well as has made outstanding contributions to Xiangyang City becoming the first grain big city with grain total output of more than ten billion jin in the Yangtze River Basin.

3. Water Conservancy Management

The perfect water conservancy management system is the guarantee for the sustainable development and utilization of Changqu irrigation agriculture. The water conservancy management of Changqu adopts the official and private management mode. In the course of its historical development, the rules and regulations related to the management, such as annual repairs system, water management and funds management, are gradually perfected and some of them continue to be preserved so far, which is a model for the sustainable management of irrigation projects.

At the end of the 11th Century, Changqu had the effective water management technology and system guarantee. Sun Yong, Magistrate of Yicheng County in the Northern Song Dynasty not only rebuilt the project, but also established the management system of civilian self-governance and government supervision for the irrigation areas: "establishing water management system to make the irrigation project well organized." [4] "Shift irrigation" system adopted by Changqu is an innovative approach to the management of water conservancy projects and is still in use today as well as has achieved the innovation development. The main practice is to divide the irrigation area into 4 areas and irrigate them from top to bottom in the divided periods. The main canal and branch canal has dozens of "Water gates", which will raise the water level nearby at the time of water supply and directly irrigate. The specific method is to take 9 days (216 hours) as a round: 48-hour water supply above the check gate in the first section, 56-hour water supply above the check gate in the second section, 50-hour water supply above the check gate in the third section and 54-hour water supply above the check gate in the fourth section and 8-hour flexible time for maintenance and repair.

In the 12th Century, the Xiangyang area in the middle reaches of the Hanjiang River became the key point of confrontation between the Southern Song Dynasty and Mongolia. The central government of the Southern Song Dynasty attached great importance to the treatment and management of the irrigation projects in Xiangyi Irrigation Area for the needs of the military field and the emperor had

issued the imperial edict for many times personally for finishing as well as the government and the army jointly managed the irrigation project in this area. In this period, the project system was more perfect and the canal was connected with the impouding reservoirs, densely covered by rivers and canals. Xiangyi Plain became the special economic zone of "fertile soil and no disasters within hundred miles".

From the 13th Century and early 20th Century, Changqu adopted the management system combined with official and civilian self-governance. Local squire played an active role in local water conservancy affairs.

At present, Changqu is managed by Xiangyang Sandaohe Administration of Hydropower Project, inheriting, developing and innovating the management measures of storage-diversion-extraction water supply, shift irrigation, rational allocation, water storage and saving, democratic management and multiple investment and construction of Changqu.

4. Heritage Composition

Changqu water conservancy heritage includes irrigation engineering system and related heritages. The heritages of irrigation project consist of canal head pivot, canal system engineering and regulation and storage engineering. The canal head engineering is located at the junction of the main stream of Manhe near the Wu'an Town in Nanzhang County and tributary of Qingliang River. It is low dam lateral diversion, with the dam length of 120m and height of 3.4m. At present, the main water source of Changqu is Sandaohe Reservoir and the irrigation area is across Nanzhang County and Yicheng County (City). The total length of main canal is 49.25km, with 34 branch canals. The canal gathers a lot of reservoirs and weirs along the line. At present, there are 10 small and medium-sized joining reservoirs, 2161 weirs in the irrigation area. The reservoirs are connected to Changqu with canals and ditches and controlled by water gates.

In addition to the engineering heritages, Changqu has many cultural relics, including sacrificial and memorial places reserved near the irrigation area, the inscriptions and documents related to the water events. They have witnessed the history of Changqu and constituted a unique cultural landscape with the engineering heritages in the irrigation area.

5. Value Analysis

Changqu (Baiqiqu) Irrigation Project lasted more than 2000 years. With its scientific planning, ingenious layout, perfect engineering system and effective management, it has guaranteed the continuous effect of the comprehensive benefits of agricultural irrigation and witnessed regional natural, social and economic changes and has outstanding historical, cultural and scientific values.

5.1. Science and Technology Values

Survey, planning and design techniques. Changqu Project has a huge scale and scientific and reasonable planning and design. According to the records on the ancient Changqu in the *Xiangyang Prefecture Chronicles* and *Yicheng County Annals* and compared to the map made by aerial survey before restoration during the period of the Republic of China (1938), the canal line of the ancient and current Changqu is basically consistent and main canal is arranged from west to east in the highest line of the second terrace of the Hanjiang Plain. The entire irrigation area located in the east and south of the main canal is under its control, ensuring the artesian diversion of branch canals and other lower channels. In addition to the reasonable planning of the canal system trend, the longitudinal slope and cross sections of the canal also meet the design of longitudinal slope of artesian diversion canal. According to the survey results and combined with the gradient estimation at present, the average slope of Changqu at present is about 1/3000.

Barrage construction (weir building) technology. When the construction of canal head project begins, the barrage for intercepting the transverse riverbed shall be built to raise the water level and divert water into the canal. "Fill the gaps with small bamboo cages with stones and earth to form a barrage". Changqu barrage construction means a bamboo cage type barrage was formed by filling

small bamboo cages with stones and earth, "cutting bamboo, cutting wood, with soil and stones, fixing the embankments, preventing transverse collapse, preventing collapse and dredging silt." The biggest advantage of bamboo cage engineering is to gather scattered pebbles together to resist floods and drain water as well as adapt to the changes to riverbed.

Multi-source water diversion and joining reservoirs. The ancient people connected the impouding reservoirs with fields by canals, "ponds connected with the canals", not only connecting the existing impouding reservoirs, but also excavating new impouding reservoirs (new impouding reservoir covering an area of dozens of hectares in the west of the city, Tumenpo in the northwest, Chouchi in the east and Zhuhupo below Chouchi) and many branch canals, just like connection of main canal, branch canals, lateral canals and field canals. If the canal head barrage is metaphorically referred to as "Melon root", the channel is like "Melon vine", and the impouding reservoirs connected along the canal are "Melons" on the melon vine. There are 49 "Melons" (impouding reservoirs) on the "Canal vine", connected in parallel into a net with high storage capacity and drainage to supplement water sources. In the non-irrigation season, the barrage is used to store water to make the river water enter the canal and canal water enter the impouding reservoir so as to expand the water sources; in the irrigation season, the impouding reservoir supplies water to Changqu to irrigate the fields, forming circulated water storage and supply, which improves the utilization rate of the impouding reservoirs.

5.2. Historical and Cultural Values

The construction of Changqu can be traced back to the end of the Warring States period, developed over the past thousand years and matured in the Southern Song Dynasty. The Yan and Ying War by water diversion from Changqu was an important battle in the Warring States period that has influenced the whole situation. Because this war destroyed the great number of elite presidential guards of Chu State so that Chu State cannot recover after a setback, the great cause of reunification of Qin State was accomplished. The sustainable use of Changqu not only has a significant role in developing the local agricultural economy, but also had a profound impact beyond the local economy in history. Historically, it has been an important commodity grain supply base and military base for many times.

Over the past two thousand years of Changqu operation, there were many enlightened politicians who have organized the civilians to carry out the maintenance and expansion works for many times. Later generations, for the sake of remembrance, once built a monument in five miles along the main canal and built a temple in ten miles, leaving many memorial buildings. Although most of these temples and inscriptions were destroyed by the wars of the past dynasties, only from the many cultural relics that survived, they have great effects on the study of the politics, economy, military and culture of the region where the irrigation area is located.

In the past 2000 years, Changqu has attracted many politicians, litterateurs and far-sighted personage for sightseeing, contributing ideas and exerting efforts or doing things by themselves, leaving a lot of verses, ditties, odes and songs and articles. Many of them are great works and can be said to be imperishable works. The well-known works include: *Changqu in Yicheng County of Xiangzhou* written by Zeng Gong, one of the Eight Masters of Tang and Song Dynasties; *Lingxi Weir* of Ouyang Xiu; *Muqu in Yicheng County of Xiangzhou* written by Zheng Xie, Hanlin Academician of Song Dynasty; *Reconstruction of Wu'an and Lingxi Weirs* written by He Wenyuan of Yuan Dynasty, etc. Of course, the most popular one is *Ode to Changqu* of Hu Zeng, a famous poet in the Tang Dynasty. Not only that, the chronicles of the past dynasties, such as *History of the Song Dynasty· Canal Chronicles*, *Comprehensive Geographical Annals of the Great Yuan Dynasty*, *Comprehensive Geographical Annals of the Great Qing Dynasty*, *General Annals of Hubei*, *Xiangyang Prefecture Chronicles* and *Nanzhang County Annals*, have detailed records. For the modern refined scholars, the literary works related to Changqu are numerous.

5.3. Science Education and Landscape Values

Changqu stretches across Nanzhang and Yicheng, with rich mountain and water resources, beautiful ecological landscape, distinctive human landscape characteristics and profound water conservancy

historical and cultural foundation. It is a "National Water Conservancy Scenic Spot" and "National Science and Technology Demonstration Park for Soil and Water Conservation". It is also a key cultural relic protection unit in Hubei Province and hydrologic information education base in Hubei Province. In recent years, the irrigation area have actively integrated tourism resources, such as natural, human and historical resources in the canal basin, constantly improved the infrastructure and strengthened the waste water ecological control. Through continuous efforts, in terms of historical materials, a data bank covering the historical documents of Changqu in Qin, Han, Northern Dynasties, Tang, Song, Yuan, Ming and Qing Dynasties has been formed; in terms of historical relics, the "Changbeige" was built, holding the relics of precipices and steles in the Yuan, Ming and Qing Dynasties; in terms of green development, led by "Spring flowers, summer shade, autumn fruits and winter green", more than 620,000 trees will be planted in the canal system of Changqu to afforest 49.3km canal and create a beautiful landscape canal integrating flood control channels, ecological corridors and green landscape.

6. Conclusions

Changqu is a model of irrigation projects in China. This project has rational layout and ingenious design and its pivotal project has basically retained the traditional low dam water storage, flood discharge and lateral diversion. The ancient and current canal lines are basically the same, irrigating the vast farmland in Xiangyi area and playing an irreplaceable role in promoting the regional social development and economic prosperity and resisting the natural disasters. Over the past two thousand years, an important irrigation benefit has been brought into play by the mode of official and private management, which makes Xiangyang become a fertile land in the world and has bred rich regional culture.

Acknowledgments

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References

[1] Zhong Q.L., Li P.H. (1999) Study on historical and cultural value of Changqu, PEARL RIVER, 05:30-31
[2] Li J.F.. (2008) General Geography of the Yuanhe Reign. Zhonghua Book Company, Beijing.
[3] Compilation Committee. （2003）Changqu Annals. China Local Records Publishing Press，Bei Jing.
[4] Compilation Group. (1989) water resources history of China. China Water&Power Press, Bei Jing.